TITLE:

Vertical Vortex/Laminar Flow Interactive Biomedia Water Treatment

CROSS-REFERENCE TO RELATED APPLICATIONS:

This application claims the benefit of Provisional Application 60/040690, filed 13 March 19[illegible]

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY-SPONSORED RESEARCH AND DEVELOPMENT:

None

FIELD OF THE INVENTION:

The invention relates generally to water treatment. In particular, the invention relates to water treatment employing vertical vortex or laminar flow in conjunction with interactive biomedia.

DESCRIPTION OF RELATED ART:

Waste liquid treatment is widely recognized as a critical factor in maintaining and improving environmental quality. Governmental environmental protection agencies at

several levels have promulgated standards regulating the specifications and effectiveness for processes and devices intended to remove or reduce contaminants in waste liquid. Of particular concern are grease, oil, sugars, and other contaminants in waste water generated by food service establishments and industrial processing facilities. Grease and oil are especially problematic, as these substances are major contributors to blockages and backups in drains and main waste lines. Grease and oil blockages can produce unpleasant odors and hazardous materials dangers, often requiring costly pumping of interceptor tanks and, in extreme cases, evacuation of waste mains, drains, and tanks.

In order to deal effectively with contaminants, it is optimal to separate the waste from the water, retain the waste while allowing the water to pass through, and dispose of the waste. Known treatment systems typically concentrate primarily on the separation aspect of this three-part process, to the detriment of equally critical retention and disposal steps.

For example, U.S. Patent No. 5,779,886 to Couture is directed to media suitable for trickle filters and biological treatment of effluent or sewage. The media comprise an elongated member having a center core, a plurality of axially extending ribs, a plurality of fins extending outwardly from each rib, and a plurality of outwardly-extending vanes situated at the distal end of each rib.

U.S. Patent No. 3,589,518 to Brebion is directed to a streaming filter to purify polluted waters by bacteriological aerobic action. The filter includes a plurality of units arranged juxtaposed in substantially vertical alignment. Each of the units has a thin-walled structure with continuous exchange surface throughout the entire height of

the filter. The filter has a cylindrical form with an internal cellular structure integral with the cylinder.

Devices such as those shown in the Couture and Brebion patents are used in the context of "impounded" waters, involving repeated cycles of contact either by recirculating the waters over the surfaces, or rotating the surfaces through the water. These devices are ineffectual in environments where there exist large volumes of flowing water, and furthermore fail to perform separation, retention, and disposal for complete water treatment.

It can be seen from the foregoing that the need exists for a simple, reliable waste liquid treatment system that will perform separation, retention, and disposal functions in the context of high volumes of flowing water.

SUMMARY:

These and other objects are achieved by providing a waste liquid treatment system. The system includes a plurality of flow control elements presenting a plurality of waste liquid flow control surfaces. A biofilm covers at least some of the waste liquid flow control surfaces. The flow control surfaces are adapted and constructed to produce alternating venturis and variable speed vortices as waste liquid flows through the flow control elements.

In an embodiment, each of the flow control elements comprises a series of fins and vanes forming the water flow control surfaces. Each of the flow control elements can include an inner member having a longitudinal axis, with a plurality of vanes

extending radially from the longitudinal axis. A cylindrical outer member can be provided surrounding the inner member, the cylindrical outer member having an outer surface including a plurality of radially projecting longitudinal fins formed thereon. In a specific embodiment, the inner member has eight vanes, and the cylindrical outer member is provided with four fins. The flow control elements can be formed from a plastic material.

The biofilm can be provided as a biofilm-expressing bacteria, providing an endemnic or seeding biofilm. The nature of the biofilm depends upon the nature of the liquid to be treated and the specific contaminants to be removed. Examples of suitable biofilms include pseudomonous species based biofilm and biofilms including sulfur-reducing bacteria species.

A method of treating waste liquid is also disclosed. The method first includes the step of providing a plurality of flow control elements presenting a plurality of waste liquid flow control surfaces. Next, at least some of the waste liquid flow control surfaces are covered with a biofilm. The waste liquid is then caused to flow through the flow control elements to produce alternating venturis and variable speed vortices as waste liquid flows through the flow control elements.

The features of the invention believed to be patentable are set forth with particularity in the appended claims. The invention itself, however, both as to organization and method of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side elevational view of a waste liquid treatment system in accordance with the present invention.

FIG. 2 is a sectional view taken generally along lines II-II of FIG. 1, and schematically illustrates flow through a waste liquid treatment system in accordance with the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings, and will herein be described in detail, exemplary embodiments, with the understanding that the present disclosure is to be considered as illustrative of the principles of the invention and not intended to limit the invention to the exemplary embodiments shown and described.

FIGS. 1 and 2 illustrate a waste liquid treatment system 10 including a plurality of flow control elements 12. In the illustrated embodiment, each flow control element 12 includes an inner member 14 having a longitudinal axis A, with a plurality of vanes 16 extending radially from the longitudinal axis A. At least one cylindrical outer member 18 can be provided surrounding the inner member 14. The cylindrical outer member 18 has an outer surface 20 including a plurality of radially projecting longitudinal fins 22 formed thereon. In the illustrated embodiment, the inner member has eight vanes, and the cylindrical outer member is provided with four fins. The flow control elements 12 can be

formed from a suitable plastic material, as dictated by the specific environment in which the system 10 will be employed.

As shown in FIG. 3, the flow control elements 12 present a plurality of waste liquid flow control surfaces adapted and constructed to produce alternating venturis 24 and variable speed vortices 26 as waste liquid flows through the flow control elements 12 in the direction of the arrow 28. The speed of the respective vortices is determined by the angularity of each vane 16 to the flow direction.

An attaching bacteria, here shown in the form of a biofilm 30, covers at least some of the waste liquid flow control surfaces. The biofilm 30 is generated by any bacteria or inoculate capable of expressing biofilm. Particular example of such substances are generally known to those of skill in the art, and are selected on the basis of the particular waste liquid to be treated and the nature of the waste present in the liquid. For example, in an aqueous solution of fats, oils, grease, nitrates, or nitrites, a biofilm using a pseudomonous species based biofilm would be suitable. For lipid disposal, an attaching bacteria expressing lipases, such as pseudomonous and/or bacillus species would be appropriate. In the case of metal sulfites, a biofilm generally expressing sulfur-reducing bacteria species would suffice. The biofilm can be provided as a biofilm-expressing bacteria, providing an endemnic or seeding biofilm. The nature of the biofilm depends upon the nature of the liquid to be treated and the specific contaminants to be removed. Examples of suitable biofilms include pseudomonous species based biofilm and biofilms including sulfur-reducing bacteria species.

The present invention performs the three functions of waste separation, retention, and disposal. Separation is accomplished by the varied low pressures within the

vortices. The varied speeds of the vortices facilitate the coalescence and ascension of lighter-than-liquid materials suspended in the waste liquid flow. The varied speeds of the vortices also facilitate precipitation of heavier-than-liquid materials suspended in the waste liquid flow.

Retention is accomplished by orientation of the flow elements. At the top of the treatment system 10, the cylindrical members 18 located superior to the static liquid line 32 within a containment prevent the lighter-than-liquid materials suspended in the waste liquid flow from moving horizontally in the containment via boundary layer turbulence, thus increasing the retention efficiency of such materials. At the bottom of the treatment system 10, the cylindrical members 18 located below the static liquid line 34 within the containment prevent the heavier-than-liquid materials suspended in the waste liquid flow from moving horizontally along the bottom of the containment, thus increasing the retention efficiency of such materials. The provision of both upper and lower cylindrical members 18 simultaneously increases the efficiency of retention of both lighter-than-liquid materials and heavier-than-liquid materials suspended in the waste liquid flow.

Disposal is achieved by the inoculation of the of the media with a suitable species of surface attaching bacteria, chosen on the basis of the characteristics of the waste to be removed from the waste liquid. The bacteria causes a biofilm to form over the entire surface of the flow elements, with greater concentrations of the biofilm on the trailing surfaces relative to flow. The vertical axis vortices repeatedly wash the waste materials over the biofilm-coated surfaces in the areas of greatest bacterial concentration without altering the principal direction of waste liquid flow. Increased contact between the

retained waste material and the attached biofilm increases the opportunity for bacteria/waste contact, thus facilitating disposal of the retained waste by metabolic activity.

While details of the invention are discussed herein with reference to some specific examples to which the principles of the present invention can be applied, the applicability of the invention to other devices and equivalent components thereof will become readily apparent to those of skill in the art.

Accordingly, it is intended that all such alternatives, modifications, permutations, and variations to the exemplary embodiments can be made without departing from the scope and spirit of the present invention as set forth in the appended claims.

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